Rebound Driven Time-dependent Geoid, Crustal Motions and Issues Related to Seismicity Patterns in Antarctica

E.R. Ivins[1] & T.S. James[2]

[1]Division of Earth and Space Science, JPL/Caltech, MS 300-233. 4800 Oak Grove Dr., Pasadena, CA 91109-8099 - U.S.A, Tele. 001-818-354-4785, FAX 001-818-354-9476 (eri@scn1.jpl.nasa.gov).

[2]P.G.C Geological Survey of Canada, 9860 Saanich Rd., Sidney, British Columbia V8L 4B2– Canada (james@pgc.nrcan.gc.ca)

Forward models of ice loading and unloading on the Antarctic continent during the late-Quaternary and Holocene predict present-day post-glacial rebound crustal motions at a rate of 2-20 mm/yr (James and Ivins, 1998; Ivins et al. 2001, Wahr et al., 2000), sufficiently large that they should be geodetically detectable. Several continuous mode observational systems using GPS on crustal bedrock are now well-underway (e.g., Raymond et al., 1999; Donnellan and Luyendyk, 1999; Malaimani et al., 1999; Tregoning et al., 2000). Accompanying these predictions are time-variable geoid changes (Ivins et al., 2001) and relative sea level variations documented to be of order 10 meters, or more (e.g., Zwartz, et al. 1998). An important addition to these model-data constraints is the prediction of seismic activity associated with glacial unloading and post-glacial rebound, in general. Here we discuss the role played by Holocene and present-day seismicity and the potential for use as an ancillary geophysical observation that may help constrain ice load history, lithospheric thickness, mantle viscosity and tectonic pre-stress orientation. For a nominal mantle viscosity and lithospheric thickness (10^21 Pa sec and 120 km, respectively) and either ICE-3G or D-91 load history types, the interior of the west Antarctic continent evolves through a phase of heightened susceptibility to thrust faulting during pre-Holocene times when glacial recession initiates (circa 21-11 kyr BP). The change in Coulomb stress toward failure is of order 5 MPa during the early Holocene. This phase wanes during the mid to late Holocene at rates of 1 to 0.25 MPa/kyr. At the peripheral margins of the unloading ice sheet strike-slip faulting is the preferred failure mode, but the Coulomb stress magnitudes are reduced by a factor of two or more.

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